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Kongsberg Seatex AS

KONGSBERG

To: MBR Users / National Frequency Authorities

Date: 2016-11-08

Subject: **MBR Technical Description**

ACCEPTED/FILED

JAN - 3 2017

Federal Communications Commission
Office of the Secretary

Maritime Broadband Radio

1. MBR Technical description

The Maritime Broadband Radio (MBR) is a real-time, phased array, digital radio that operates in the 5 GHz band and offers high speed reliable data transfer between vessels and structures at sea, mainly in connection with offshore operations for increased safety and efficiency. The MBR system is based on radio transceivers operating in the 5 GHz band, and so far the following center frequencies have been used: 5180 / 5230 / 5862 / 5890 MHz.

The channel bandwidth is 20 MHz (±10 MHz with respect to the center frequency).

In order to get a standard frequency allocation for MBR, CEPT is now considering to make 5862 and 5890 MHz standard frequencies for MBR.

The system operates in duplex mode on a single frequency with data throughput of 1 to 15 Mbps.

A main feature of the MBR system is an integrated antenna array with steerable antenna lobes. The antenna system consists of up to 60 antenna elements, each one with its own power amplifier which can be controlled in amplitude and phase. The antenna radiation diagram can therefore be tailored to the optimum diagram in real-time. Normally, all antenna elements will be driven in phase and amplitude, thereby obtaining a high antenna gain and a narrow antenna lobe. The antennas can hence direct the main antenna lobe in the optimal direction for communication. The communication system may consist of multiple nodes and the adaptive antenna arrays use beamforming to establish multi-point network functionality.

When communication is established, the transmitting antenna and the reception antenna are both aligned towards each other by software controlled antenna lobes. The transmission therefore takes place within a relatively small closed volume. The major part of the e.i.r.p. will be in the direct line between the transmitting and receiving antenna. The use of beamforming permits the production of shaped and dynamically steerable beams in several directions, thereby enabling the desired system performance objectives to be maintained as the vessels move relative to each other and, at the same time, minimizing interference for other co-frequency systems. The tailored radiation patterns are optimized to reduce interference and to allow operation at lower transmit powers than would otherwise be necessary if more conventional fixed antennas were deployed.

The available transmission output power in the narrow antenna lobe (e.i.r.p.) of the MBR system is designed to be high in order to achieve a long communication range with sufficient link margin. The high peak power is achieved by coherent beamforming of a large number of antenna elements where each individual element has a low radiated power. In the far-field the phasing of the antennas form a narrow beam that focuses the energy and leads to a high e.i.r.p. in the direction of interest. Using a large number of antenna elements will provide low field intensity in the near-field area and an equivalent high power emission in the far-field.

The MBR antenna has high gain and directivity by electronically combining each individual antenna and the total antenna gain is 24 dBi for MBR 189, and 21 dBi for MBR 179.

The antenna has steerable fan shaped beams that can be steered spatially within operational freedom of the antenna. For the MBR 179 the beam can be steered 360° around the horizon, and for MBR 189 the beam can be steered ± 50° horizontally and ± 50° vertically. The - 3 dB width of the beam is less than 10° and the - 10 dB width is less than 16°.

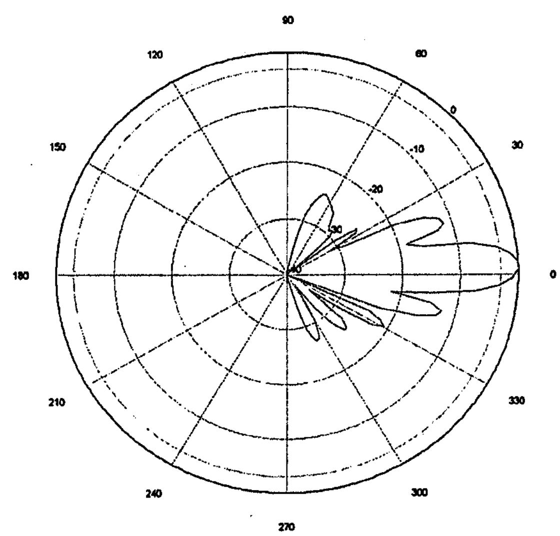

Figure 1: Nominal radiation pattern in the vertical and horizontal plane (cone shaped) of the steerable antenna beam in a given direction

The MBR system optimizes the link budget under different conditions and uses adaptive power control to regulate the output power to the minimum necessary for the communications. The link margin is measured and exchanged in real-time and the sender will then know how much output power is needed for maintaining link with an acceptable margin.

The built-in function, Adaptive Power Control (APC), and will reduce the output power to an acceptable signal margin at the receiver. Each transmitted package contains information on the transmitted power level. The receiver measures the received signal strength, calculates the quality of the link and indicates suitable power reduction. The output power may be reduced up to 25 dB. **Figure 2** below show measured path loss in blue and MBR TX power for the same link path. The power is reduced and never at maximum TX level for distances closer than 40 km. Antenna height for first radio station is 20 meter above sea level and 30 meter above sea level for the second station.

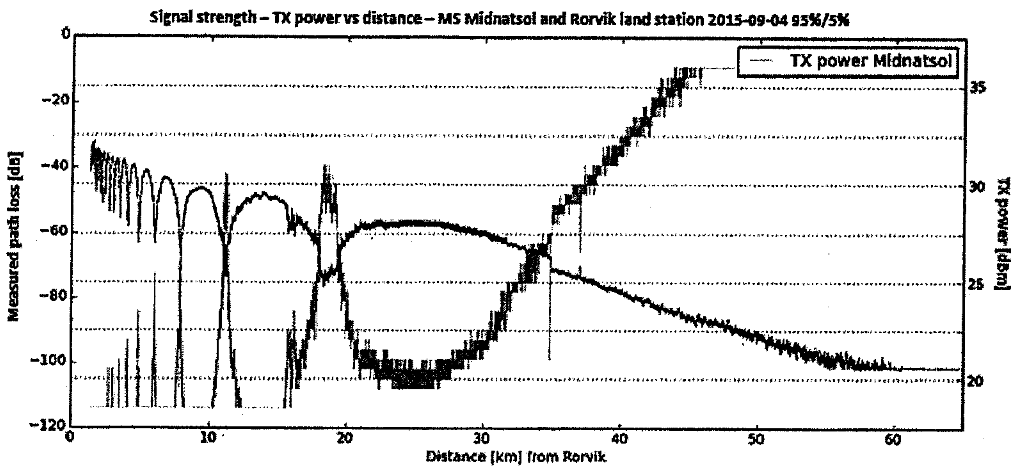

Figure 2: Measured path loss and transmission power with adaptive power control

For a normal MBR network of 4 participants the operational range will be less than the maximum range in order to have an acceptable link margin. For the network in this example with maximum range at 40 km the interference probability is reduced by the following key factors:

- Only one radio station can transmit at the same time since the system is TDMA based
- The narrow steerable beam will give 2.5% probability at 9 degrees width for transmitting in any direction.
- Adaptive Power Control will reduce the power levels with up to 25 dB and reserve the maximum available e.i.r.p for the short time sea fading conditions. See **Figure 3**.

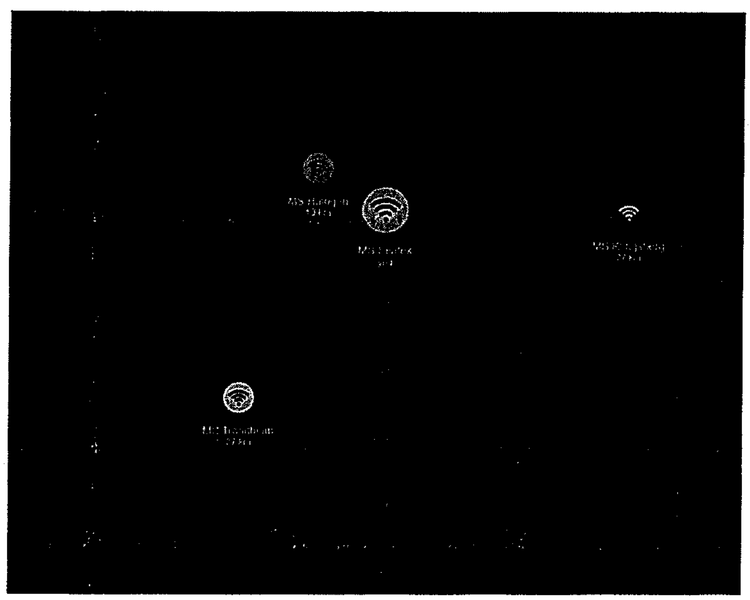

Figure 3: Typical MBR network with 4 participants

The bandwidth of a MBR channel is 20 MHz. The transmitter emitted power density outside the band fc ± 50 MHz is < -31 dBm/MHz. The transmission spectrum mask is shown in **Figure 4.**

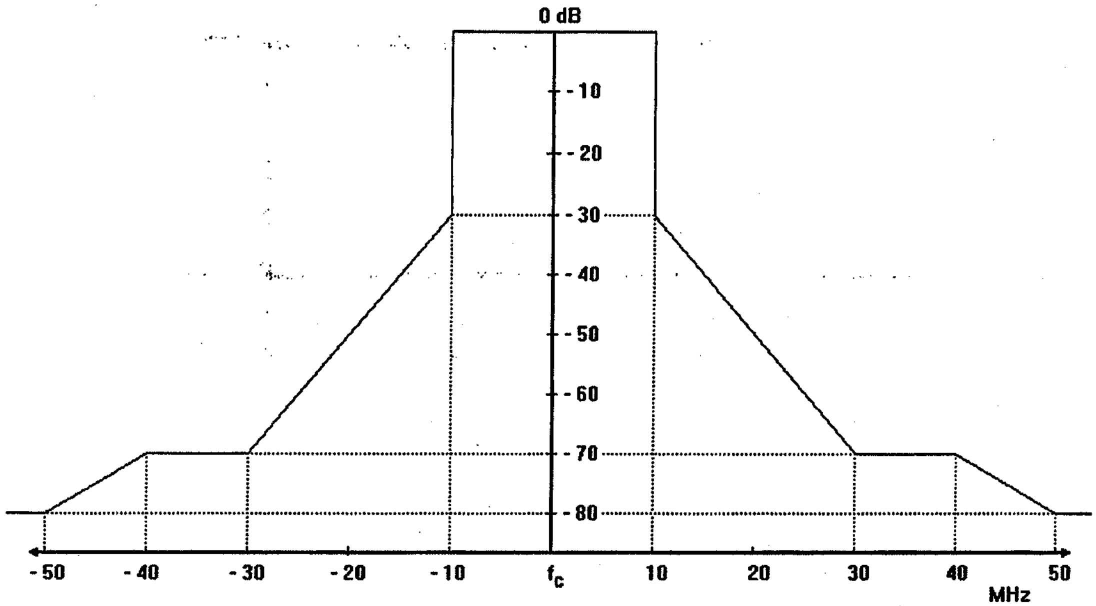

Figure 4: Transmitter output power spectrum mask

2. Conformity Declaration

KONGSBERG

DECLARATION OF CONFORMITY

(according to ISO/IEC 17050-1)

Manufacturer's name: **Kongsberg Seatex AS**

Manufacturer's address: **Pirsenteret, N-7462 Trondheim, Norway**

declares that the product:

Product name: **Marine Broadband Radio, MBR**

Model numbers: **MBR 179 and MBR 189**

Product options **MBR Power Supply**

is in conformity with the **R&TTE directive 1995/5/EC** which also implies conformity with applicable EMC and safety regulations. Relevant sections of the following product standard have been used for product testing:

Radio: **ETSI EN 301 893 V1.7.1**

Test reference
Test Report Radio: 264318-03, issued by Nemko AS

Notified Body report reference
Report: NBO 0470-RTTE-151201, issued by Nemko AS

Supplementary information
R&TTE conformity implies compliance with EMC and safety regulations and the following standards have been used for assessment:

EMC: **EN 60945 (2002);**

Electrical safety: **EN/IEC 61010-1 (2010)**

Report references:
EMC: Report E14212.00, issued by Nemko
Safety: Report KSX-2014-5-MBR, issued by Kongsberg Seatex AS

The product was tested in its normal configuration.

Date and signature
2015-04-07

Arne Rinnan

Arne Rinnan, CTO